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ABSTRACT

Since the early 1990s and birth of the World Wide Web, instructional experimentation with Internet integration has been undertaken. While efforts are varied, usage of the Internet can be grouped into three general categories: communication supplements, course management aids, and course content supplements. Communication supplements are those that enhance the interaction between instructor and students. Course management aids provide organization and computerized mechanisms for both delivery and collection of course material and also serve as interactive study guides. Course content supplements add outside readings and materials to contribute to and enhance textbook subject matter. From a cross-disciplinary perspective, this paper highlights how the Internet can be used to increase learning and the interest to learn, and reduce the costs of course management, research, locating educational information, and communication. Experiences in business, economics, and engineering courses are given and generalized to other disciplines. (AEF)

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Hybrid Courses: Determining the Effectiveness of Using the Internet

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Abstract. This cross-disciplinary study identifies several of the benefits and costs associated with using the Internet to complement not compete against, the chalk-and-talk learning environments of instructors.

1. Introduction

Since the early 1990s and birth of the Web, instructional experimentation with Internet integration has been undertaken. It is time now for educators to identify the benefits and costs associated with utilizing the Internet to complement the solid educational structures tried and tested by so many traditional instructors. By relying on the Internet to complete previously time consuming tasks, can instructors reallocate their resources toward improving their educational environments in fashions valued by their disciplines?

While efforts are varied, usage of the Internet can be grouped into three general categories: communication supplements, course management aids, and course content supplements. Communication supplements are those which enhance the interaction between instructor and students, and between students. The latter is particularly true in courses where teams are a large part of the course structure. Course management aids provide organization and a computerized mechanism for both delivery and collection of course material. They also serve as an interactive study guide vehicle. Course content supplements add outside readings and materials to contribute to and enhance textbook subject matter.

From a cross-disciplinary perspective this paper highlights how the Internet use can be used to increase learning and the interest to learn, and reduce the costs of course management, research, locating educational information, and communication. Experiences in business, economics, and engineering courses will be relayed and generalized to other disciplines.

2. Internet Integration in Information Systems

By most measures, information systems is a discipline still in its youth with little more than 25 years of existence. From the standpoint technical innovativeness in teaching this youth has been a distinct advantage. Without a legacy of tradition to overcome, faculty are more likely to experiment with new techniques. The discipline's computing emphasis further adds to the likelihood of instructional technology use, and the Internet was a logical and early step.

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2.1 Communication Supplements

Notifying students of announcements using a group email list has proven much more effective than maintaining an announcements web page. Students typically check their email daily, so class email taps into an already active medium. Less effective was a class announcement web page that students were to visit on their own initiative. Since daily announcements rarely occur, students quickly abandoned a daily check-in routine and missed announcements.

Online office hours can be conducted in two ways: preset times during which email will be answered immediately or replies sent whenever the instructor is online with a minimum email check of once per day. Much like getting a paper letter out before the postal carrier arrives, using a preset time lets students know what time of day their email will be read and to make that deadline. This simulates physical office hours the most closely, but also has its disadvantage of limited availability. Online, anytime office hours can become an intrusion to the instructor; it is near the equivalent of saying, "here's my home phone number, call me anytime." When the instructor doesn't reply quickly, students criticize availability even when email is answered within 12 hours. The solution is a balance of setting expectations while meeting the needs of students in a particular class—some classes simply need more instructor availability than others.

In situations where student teams are heavily used, student-student email with file attachments, bulletin boards, and chat rooms expand team meeting time outside of class. Students with class, work, and home schedules typically have little common time to meet on class projects. Training team members to regularly use these features has meant the difference between success and mediocre team performance.

2.2 Course Management Aids

Distribution of course materials via the web continues to be one of the first points of web integration [1] and has a quick return. Putting a course syllabus, handouts, and assignments in a website for student retrieval reduced some paper copies, eliminated problems of lost papers and obtaining replacements. The website became a course portfolio and helped students with their own organization. By keeping the site active, students were also more apt to relook at the syllabus on a regular basis. Many students indicated that other paper-based syllabi remained buried in their notes after the first week of classes, but the active online syllabus was reviewed at least weekly. Photos taken during class of team presentations and exercises were added to the course website to make the growing portfolio have some visual student ownership. An example is shown in Figure 1. It is not clear whether this was perceived as a gimmick or appreciated as a personal touch, but no complaints have been voiced regarding either the photo taking or postings.

Two additions to the course website have been successfully used: posting class minutes, shown in Figure 2, and grade retrieval. Class minutes, taken by students in rotation, summarize the content and announcements of a class period. These written notes are posted to the website by date and used by students who miss a class period as well as attending students who want to verify their own notes. If the instructor confirms the content (and adds notes in italics) these minutes serve as documentation and a source of reference in case of dispute. Grades can be posted for individual query by password or as a class list with anonymous posting ids. Some students prefer the individual postings for better privacy while many others like to measure their performance against the rest of the class. Use of grade postings is dictated by objectives, university policy, and instructor technical skills (individual posting querying requires more sophisticated software), but students definitely want to see their official grade standings.

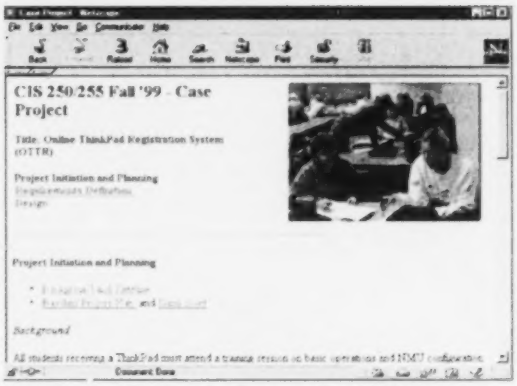

Figure 1. Course Portfolio

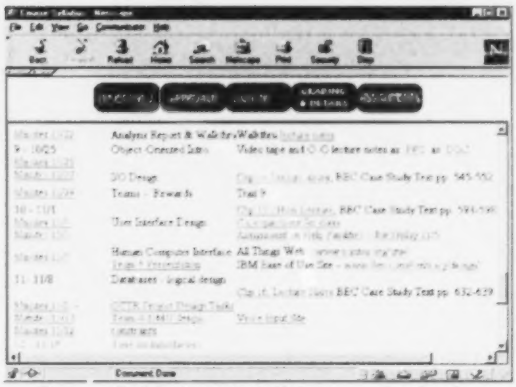

Figure 2. Material delivery and minutes

Course websites moved past a passive delivery to a feedback device when interactive features were added. Assignments collected online as file attachments or sent with ftp to a dropbox folder can be electronically graded (instructor comments in alternate font) and returned. This was especially true for team assignments as all teams members received a copy the graded file. Beyond this, posting select submissions or solution files to the website provided students with accurate models.

Online testing is a second avenue for student interaction with several levels of complexity: simple posting of prior exams, online practice tests with immediate feedback, and actual testing. While students indicate they want these features, it may not be the best return on time invested for two reasons. Many students do not actually use these practice test features, even though they request them. Others limit their studies to just the practice test questions and ignore the overall subject. These are the same limitations of paper practice tests used for decades. Objective questions seem a crucial part of both practice and online tests in order to provide immediately scored feedback. Many instructors prefer essay questions and online tests are not a well-suited medium. However, for take-home examinations the ability to download the questions, type answers in a word processor, and electronically submit the completed exam worked well.

2.3 Course Content Supplements

From a technical standpoint, creating a course web page containing links to online references relevant to course content is not difficult. Providing quality outside readings, whether journals on reserve at the library or selected online sites, has always required care. The added caution needed in validating website content takes extra instructor time and is hard. Once an instructor locates a quality source, the task becomes easier, however, some disciplines have more volatile content mandating more effort in site selection. In information systems, currency of content is a continuous problem that use of valid websites can overcome. Assigning readings from online journals for classtime discussion keeps both instructor and students abreast of new technologies and trends.

If students are expected to include web references as part of a research project, student training on effective web use is critical. Often incorrectly assumed, is that students are web literate and easily able to locate and critically assess information. Surfing the web may be well understood, but knowing how to get the best results of search engines and evaluate them is not. Instructors should provide a training session of web research that includes query command language, evaluation criteria, and copyright infringements. If the instructor is not qualified to provide this training ask the library staff for this service. Ignoring this issue results in frustrations, lost time, and poorly written research.

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3. Internet Integration in Engineering

Engineering by definition is a discipline whereby the principles of math and science are harnessed to make products that are useful to mankind. Thus engineering education entails two specific tasks: teaching basic scientific and mathematical principles and teaching students how to design products. Learning these skills requires students to make complex calculations, simulate the behavior of complex processes, and test the effectiveness of numerous design approaches on a product—all of which are facilitated through the use of computers. As a result, computers have been an integral part of the engineering curriculum for twenty-five years—since the days of the card punch machines. In the 1980s and 1990s, computer usage was dominated by dedicated computer labs with local area networks set up for students studying computationally intensive topics. More recently, the Internet has made it possible for students to gain access to educational materials from their dorm rooms or any other computer site. The use of the Internet in engineering education is discussed in detail in [2] and is reviewed below.

3.1 Communication Supplements

The Internet provides a timely means to supplement courses with out-of-class announcements and questions and answers. These can be accomplished through e-mail, bulletin boards or chat rooms for simple announcements or simple questions. It generally takes little effort for students to ask questions via email and for instructors to answer them. Students can send email at any time of day (even at night when it would be inappropriate to telephone) and expect answers within a reasonable time frame. However, text-only formats, such as used in email, have limitations. Much of engineering homework requires analysis using mathematical and scientific expressions. Some of this can be translated into text using expressions such as x^2 for x2 and "alpha" for the Greek letter α, but complex equations cannot be transmitted over email or posted to standard bulletin boards or chat rooms. Some people have been experimenting with whiteboards for students to enter equations into a chat room [3]. The technology requires some additional software or hardware on the user side, but it does have potential for electronic communications in engineering courses.

3.2 Course Management

The basic elements in just about any course are the syllabus (including a list of required and recommended course materials, schedule, readings, course policies, instructor contact information), homework assignments and solutions, tests and test solutions. A Web server makes a wonderful storage place for these elements. It can be accessed by students at any time and it helps to organize the course. PDF format and postscript are the preferred methods of storing tests, homework assignments and solutions in engineering applications.

Online tests can be given using a course management package such as WebCT where the test can be graded automatically. For example, an online test using WebCT was given in a junior-level course at Georgia Tech. One goal of the course was to teach students how to use the software package MATLAB for analyzing system responses. The online test required students to open WebCT in one window and MATLAB in another window. The questions were given in WebCT and required students to perform some complex calculations using MATLAB to find the answers, which were then entered into WebCT. The test was given a time limit and could only be taken during a specified time window. The benefit of this type of testing is that it could ask questions that were more complicated than could be asked in a traditional classroom setting where students used only scientific calculators (rather than a computer), and it tested their knowledge of MATLAB. There are

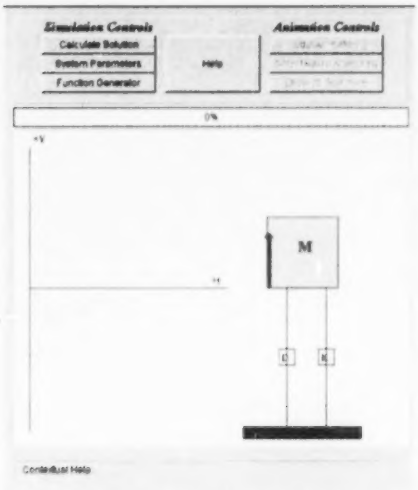

Figure 3. Initial configuration

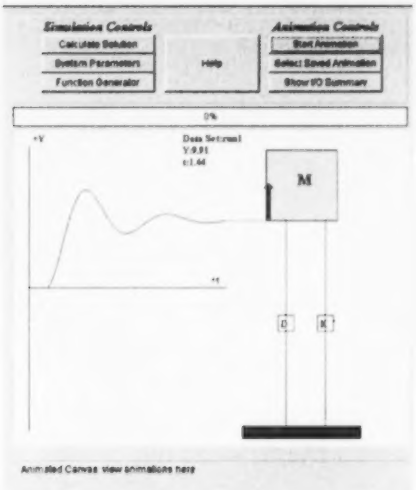

Figure 4. After student simulation

several drawbacks to this type of test. One is that it is unsupervised and may entice some students to cheat (as would any take-home test). Another is that the communication link may not be dependable. If a student starts the test and then loses the connection, how do they get back into the test environment? How is the time allotment handled in such circumstances? Students should not be able to voluntarily break the connection to work on problems off-line and then reconnect. Lastly, students have had over ten years of experience taking pencil and paper tests and in many cases are reluctant to taking any other type of test (especially one given on line). They need plenty of practice before a test is counted. This brings forth a new benefit to online testing software. A bank of practice test problems can be made available for students as a means of studying the material and working problems quickly. Their practice quizzes can be graded automatically giving students immediate feedback on their answers.

3.3 Course Content Supplements

One of the most challenging issues in engineering is for students to be able to visualize complex behavior of systems. Consider the mass-spring-damper system shown in Figures 3 and 4. This is a simple model that can represent the suspension in an automobile, the vibration of heavy equipment, or some other complex system. The mass moves up and down when a force is applied (such as when an automobile goes over a bump in the road). A JAVA applet is available on line for students to simulate the behavior of the system [4]. Figure 3 shows the applet in its initial configuration, and Figure 4 shows the applet after a simulation. Students can change the values of the mass, spring and/or damper and select different types of inputs (sudden jolts versus oscillatory inputs) using the simulation controls menu shown in Figure 3. The JAVA program computes the response mathematically and then animates the motion as well as displays a graph showing the history of the motion, see Figure 4.

Such interactive demonstrations have become very popular in teaching science and engineering. For example, the junior-level electrical engineering textbook by Kamen and Heck [4] has a Web site that is highly coupled with the text. The examples in the text contain detailed mathematical derivations. The web site has corresponding simulations and animations for the examples, such as the mass-spring-damper example described above. Students are free to change parameters in the simulation and see what happens. The animations provide more insight than mathematical analysis or even static pictures. The web site for this book also provides a bank of worked problems as a reference for students,

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a tutorial for the software used in the course, and downloadable software. All of these can be kept more up to date than a traditional textbook. The challenge for instructors is to entice students to view these demonstrations. If testing material does not cover questions about the online demos, then students may not spend the time necessary to review them.

Another trend in engineering education is the use of virtual and remote laboratories over the web. Virtual laboratories are simply elaborate demonstrations of the sort mentioned above. They generally involve use of JAVA programs and may even use a virtual reality program to simulate a real laboratory environment. A remote lab is a real lab experiment that is connected to the web. A remote user can set the parameters of the experiment and start it up. They can receive the data from the experiment. If bandwidth is not a problem, then a camera and microphone can be set up so that students can get streaming video and audio of the experiment as it is running.

4. Internet Integration in Economics

Recent studies show an increased demand for economics degrees, possibly indicating that students do not find this oft-labeled "dismal science" as being so dreadful [5]. As students return to the economics classrooms, they find that the Internet has been integrated into their learning environments. Economist instructors now use the Internet to bring students instantly to the economic data and news released by government agencies, policymakers, world organizations and business professional. The Internet allows instructors to connect their students immediately with key economic events, to communicate electronically with their students in a short period of time, to support bulletin board activities posting revised explanations of complex economic principles, and to direct students to electronic resources created, maintained and updated by economists. The electronically-supported learning environment increases the speed in which economic principles are taught and connected to real world events. Students appear motivated to learn more if instructors complement their class time with Internet components.

4.1 Communication Supplements

Electronic messaging proves efficient and effective in the economics learning environment. Students check email daily, complete electronically delivered assignments in a timely fashion, ask in-depth questions, and appear motivated to retrieve current economic information to complete assignments requiring them to do so. One clear advantage of using electronic messaging to answer commonly asked questions is that instructors can group similar questions, answer them as if they were one, and then distribute the answer to the class as a whole. Students comment that they appreciate quick responses from instructors and find value in knowing that classmates face the same types of questions.

Students use electronic office hours considerably more than traditional office hours. During the winter 1999 semester, students enrolled in a hybrid macroeconomics course used electronic office hours daily while students in a traditional macroeconomics course used them only eight times during the span of the semester. Electronic office hours demand little student time or energy in locating instructors' offices or arranging schedules to fit office hours held by instructors and help minimize formal communication barriers between students and instructors. Hybrid students do contact instructors more frequently and they do ask questions more freely than traditional students. One distinct disadvantage does exist, however, as some students email trivial questions about class status and other issues that they could easily answer themselves; email can become a crutch preventing self-solution.

From the instructor's standpoint, responding to electronic messages can be time

consuming. To manage response time effectively, instructors may wish to set designated times in which electronic messages will be addressed. This allows instructors to specialize in responding to emails while helping students form expectations about when to expect responses from their instructors. To address technical problems, instructors may want to establish a short period at the beginning of their courses in which students may bring technical issues to the instructors' attention and expect assistance from their instructors and/or their assistants.

Creating electronic mailboxes for each course to filter email messages help instructors efficiently manage their email. Instructors can require students to use preset subject-heading phrases in the subject fields of their electronic messages can filter emails by class, section, and assignment and/or topic. For example, students enrolled in Economics 101 – Section 1 submitting assignment one may be required to place EC101-1: Assn 1 in the subject field of their emails. Electronic filters can then send all messages sent by EC101-1 students to a specific course electronic mailbox where messages can then be sorted and addressed by assignment. Organizing activities like these permit instructors to address similar student questions, exercises, or issues at one time, increasing instructor productivity.

Student to student interaction outside of class increases with the use of email and bulletin boards. Students often ask each other questions about assignments, organize study groups, and ask fellow classmates for assistance in understanding difficult concepts. Electronic devices are available to allow instructors to track and record these types of student activities, a task difficult to document in a traditional learning environment.

4.2 Course Management Aids

Electronically posted course syllabi, reading assignments, exercises, past tests and class outlines help students organize course materials. Students have ubiquitous and low cost access to these materials that are deemed important by their economics instructors. This access provides students with a useful educational structures that will help guide students down their learning paths. Students appear to be self-motivated to spend the required resources needed to learn various economic concepts when their economics course syllabi contain active hyperlinks to real world organizations, consumer groups, and businesses which actively use economics principles, models, and theories to conduct activities described in economics textbooks.

Students facing long download times on the Internet or who do not have Internet access can use computer-generated exercises located on disks. Often instructors and students will use these exercises to create dynamic learning environments in economics courses. Students need to be encouraged to complete these exercises and instructors need to test students over the material learned while completing them. Otherwise, students do not possess the proper incentives needed to learn how to use the software and to complete the accompanying exercises. To teach students how to use the software and to address user issues, instructors must invest time in learning how to use the software themselves. Depending on their level of computer expertise and what must be sacrificed in order to learn how to use the software, this investment may or not pay off for instructors.

4.3 Course Content Supplements

Many electronic resources are available on the Internet for economics instructors and their students to utilize. Some economic websites help economics instructors and students locate quickly economic data and information on key economic policies, organizations, journals, trade organizations, and societies. Some websites provide interactive exercise modules that take supply and demand graphs, static in textbooks, and make them dynamic

over the Web. These sites often provide links to a wealth of information on various manipulations of demand and supply models. Using these interactive websites students gain from being able to manipulate graphs first hand, to make incorrect choices without penalty, and to receive instantaneous feedback on choices made. Still other websites provide inflation calculators and econometric models. Of course, educational objectives, instructors' teaching preferences, and level of students will influence which electronic resources will best complement the economics classroom.

5. Summary and Conclusions

Table 1 summarizes the effectiveness ratings of the Internet features as integrated into traditional courses in three disciplines. While the course content supplement features vary by discipline, there are some common threads of value in the communication and course management areas that might be generalized to most academic fields. Most significantly are group email and online postings of syllabi, handouts, and assignments. All of these take little effort or technical knowledge and provide a high return. The next level of integration with ratings of 3-4 are found to be useful, but require more skills / time on the part of the instructor. When the instructor has those skills or institutional support, these features can be of value. For a new user of instructional web technology, it may be wisest to begin with the features most related to their discipline or of general effectiveness. Use of the Internet as an integral component of a course and its delivery does not guarantee more time for other academic endeavors; however, it can result in an improvement in the quality of delivery and currency and some consistency and time savings in course management.

Table 1. Comparative Effectiveness

Internet Feature		Effectiveness rating for time spent		
		Info. Sys.	Econ.	Engineer.
Communication	group email announcements	5	5	5
	electronic office hours	5	4	
	student-student email	5	5	
	chat/bulletin board		2	4
Course Management	online syllabus	5	5	5
	online handouts/assignments	5	5	5
	posting grades	5		5
	assignment collection via web/email	4	4	3
	interactive assignment sites (problems)	3	5	3
	practice tests	3	5	3
	actual tests			3
	web-only course		2	
Content Supplement	links to outside online readings	5	5	
	required reading of online journals	4		
	required web references in research	4		
	virtual lab for simulations			4
	ftp site for downloading software	5		
Rating: blank=not used, 0=not effective for time spent, 5=highly useful for time spent				

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